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(54) **METRORÍO SYSTEM FOR REGULAR TRANSPORT OF URBAN AND INTERURBAN PASSENGERS BY RIVER AND SEA**

(57) The invention relates to a Rivertube system for transporting urban and metropolitan passengers, by river and sea, which is similar to a metro system, using watercraft instead of trains, said watercraft travelling along the rivers and coasts of cities instead of on tracks and in tunnels. The system comprises an automatic docking

system for the boats and closed or covered stops, built on the river or on the sea, with large floating platforms that enable passengers to get on and off the boats more quickly and with greater agility than in conventional metro cars.

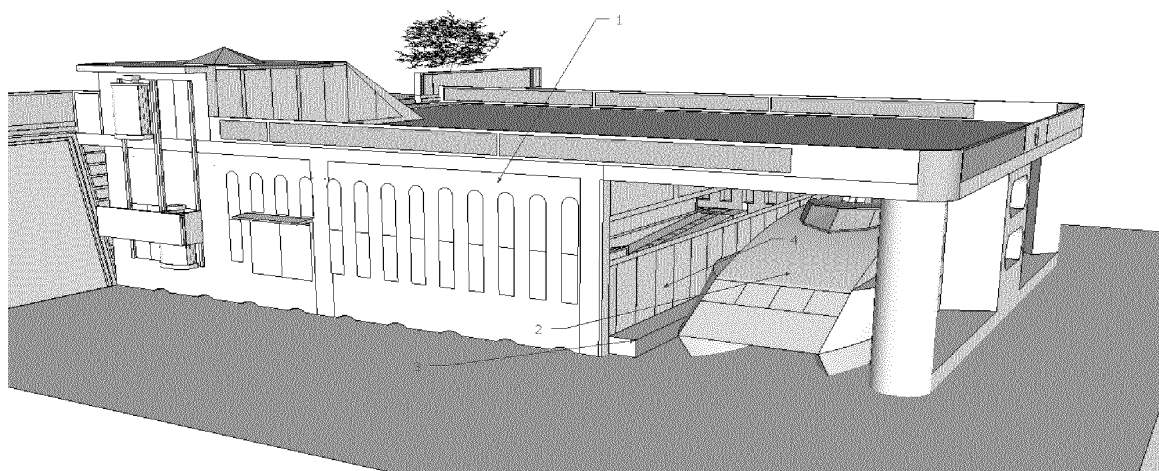


Fig.1

DescriptionTechnical sector

[0001] The invention belongs to the sector of regular passengers transport.

Technical stand

[0002] Currently, the most efficient systems of passenger's public transport in the big cities are the underground systems and mixed systems (underground and exterior), for the reason that they get circulation ways reserved to the traffic, without traffic jam or hold-up. They are trains with high capacity for users with a high frequency. This reliability, together with the great quality of the stations and of the modern trains has as a consequence that this is the most used transport method in the cities where they are established.

[0003] The main disadvantage of the system is the enormous investment required to generate the necessary infrastructures to get the system into operation, as well as the high costs of maintenance. It is necessary to drill dozens of kilometers of subterranean tunnels, excavate and construct dozens of underground stations. Besides, the acquisition of expensive train wagons, with complicated machinery, security systems, ventilation, kilometers of railways, kilometers of catenaries and dozens of electrical supply sub-stations. These systems can require the investment of more than 1.000 millions Euros for each 20 km of the line.

[0004] The system of tube by railway is sufficiently developed and standardized, so that any important city risks making this enormous investment in projects of high complexity with a high security of success.

[0005] A solution which would give the same service, using already existent fluvial lanes in many of the big cities in the world would be an improvement that would save 90% of the necessary investment.

[0006] The present invention targets on developing an industrial transport system for passengers using the fluvial lanes of big cities with the reliability, quality and efficiency of the transport of the underground tube. The system would be used in cities like London, Paris, Seville, New York, etc. The majority of the big cities have grown beside rivers or the sea.

[0007] Currently, there exist innumerable fluvial transport systems for persons but none of them propose an efficient, reliable and high quality system similar to the underground tubes. There are used ferries and standard boats, with conventional docking systems, that need more than one worker to tie ropes, to dock the boat to the quay and to open the gangway for the exchange of passengers. They use piers at open air which do not guarantee a docking time, exchange of passengers and departures similar to the stop system of the current tubes.

[0008] Almost all cities exploit their fluvial lanes, but in the way of conventional ferries. For example, the ferries'

lines City Cat in Brisbane, Australia; Water Taxis, East River Ferries, Hudson River Ferries or Beldford River Ferry in New York; Macao TurboJet Lines. Most of them are long distance lines and with little frequency or they are mainly used by tourists because of their slow operations.

Detailed description of the invention

[0009] The present invention refers to a system of urban and interurban tube that uses the fluvial lanes available in many of the big cities of the world to reduce the necessary investment to 90% without diminishing the quality, efficiency and reliability of the transport's system.

The new transport's system, that we will call from now on RiverTube, requires a number of inventions and modifications of the current tube model, that altogether represent a novel invention and repeatable, like a perfectly modeled industrial exploitation of the fluvial and sea lanes of the big cities and non-existent at present.

[0010] The system RiverTube proposes the following changes and modifications to the current concept of tube and of the passenger's transport by boat:

- The existent fluvial lanes of the city will be used, instead of creating new and expensive infrastructures, and the sea for those coast cities that allow it (or mixed systems) making a massive, efficient and secure exploitation at the same level of an underground tube.
- There will be used boats (catamarans) instead of a set of trains. For the fluvial use, the catamarans will be light and economic. It is not necessary to make investments in railways, catenaries, electric sub-stations nor subterranean tunnels.
- The catamarans will have electric motors as a propulsion system, but to eliminate the investment of the catenaries, they will use a system of interchangeable batteries. The batteries will be charged in the central stations and they will be interchanged to the boat when its batteries are unloaded. This process will take place in seconds, without slowing down the normal operation of the boat. The catamarans will be provided with solar panels, wind generators and other systems that supply the autonomy of the boat.
- The catamarans will be provided with an additional platform for the bicycle transport. This, together with its wide automatic doors, will allow the bicycle transport even in rush hours.
- The catamarans will have one or two floors, depending on the requirements of the line, the height and disposition of the bridges and the barriers to be avoided in the navigation lane. The size of the catamaran and the number of persons that can be trans-

ported will be determined by each implementation of the model.

- The passing frequency by the stations will depend on the concrete line, but it should be inferior than 6 minutes in rush hour and inferior than 12 minutes at normal times.
- The catamarans will have available an automatic docking system that reduces the necessary time for the stop and exchange of passengers in less than one minute, similar to the stop times of the modern tubes. The automatic docking system is the main invention of the model that allows making the stop in seconds and that reduces the number of required workers to only the boat pilot. The automatic docking system is one of the claims of the application of the present patent and involves the development of some inventions in the boat and at the quay.
- The docking system will have a set of automatic doors in the quay and in the boat that will open simultaneously and coordinately to avoid accidents and the fall of users into the water. The doors will have large dimensions to facilitate the exchange of passengers, baby strollers, wheel chairs and bicycles, even in rush hours.
- The catamarans will have a special design that minimizes the generation of waves to avoid the damages at the banks of the river lanes and to benefit the recreational and private use of the fluvial lane. The system foresees the creation of reserved canals to the traffic of the RiverTube in the fluvial lanes through the construction of walls that separate the traffic and isolate the waves.
- There will be installed control systems of Maritime and Fluvial Traffic VTS (definition of IALA) that will use radars, AIS systems (Automatic Information System) and surveillance cameras to locate and control all the boats in the fluvial lanes. These systems will be used to provide information to the information system for the passenger that will be available in all stops and boats. There will be installed a system of communications TETRA to communicate the pilots, workers and boats with the control and operations centre.
- There will be installed navigation simulators with the boat models and the scene of the fluvial and maritime lanes for the continuous training of the pilots and workers.
- The ticket's systems will be provided of transport titles with a magnetic band without standard contact and will have printed a QR code for the access to the services of on-line payment and recharge of the

transport titles.

- The stops (Fig. 1-1) will be closed buildings with access to a floating quay (Fig. 1-3) through mobile ramps that correct the height's difference of the water level (Fig. 2-4) by consequence of the tide or controlled changes of the level through locks. The boat (Fig. 1-2) will enter the building and there will be an exchange of passengers, after the opening of the automatic doors (Fig. 1-4) of the quay (Fig. 1-3), as if it was a subterranean station. This is a fundamental improvement of the current transport system by boats together with the automatic docking, that makes the system similar to the subterranean tube. The lathes (Fig. 2-5) provided in the station guarantee that the cancellation of the ticket will be made before getting on the boat and improves the agility of the exchange of passengers.
- The floating quay will have large dimensions to guarantee the access of a high number of persons that can get on and off the boat.
- The location of the stops will be provided according to a previous study of mobility, being recommended to place it near the bridges and walkways to bring nearer both banks of the river in the case of fluvial lanes. It is recommended also to provide the stations near the current conventional tube stations, bus stations or cycle paths.
- The metropolitan stops or exterior stops to the city will be provided with extensive dissuasive parking to attract the users that come by car from their towns not near to the river and so avoid the massive entrance in the centre of the big cities. The mobility analysis, which will be carried out before the implantation of the model, will determine the modifications that have to be made in the current transport system, like the bus lines, to bring the passengers to the stops and to relieve pressure in the urban traffic.
- The automatic doors at the quay and at the boat can be the type of vertical opening, which would provide a door's width of almost the whole length of the boat and would improve the efficiency of the passengers' exchange with respect to a subterranean tube, in which the users must first go out through narrow doors before the new users can get in.

[0011] As follows we will describe an example of use of the system with a study carried out for the city of Seville. The Guadalquivir river, flowing through Seville has two arms: the alive canal that flows from the north to the south at the west side of Seville, bordering the lands of Expo'92, Triana, Los Remedios and the commercial harbor; the inner basin (it is a lake of controlled level), closed to the north by the buffer of El Alamillo and to the south by the

new lock. Both canals represent a navigation lane free of jams to cross Seville from north to south passing through the historical center and the most important neighborhoods, unifying all the towns at the river and El Aljarafe with the capital. The exterior canal can have strong tides and can be subject of the effect of the tides. Its level can fluctuate until 3,5 meters high, while the basin is more stable and has no stream flows. In the attached documentation we render a presentation with the designed implementation for this city. In this case, there will be used catamarans with an useful surface of 20 x 8 square meters with a charge of 250 passengers in two floors. There are available 112 seats and a platform for 30 bicycles. There will be created 4 lines with 22 stops that will connect almost 40 kilometers. There will be required 25 boats to maintain a frequency of 6 minutes per stop in rush hour and 12 minutes in normal times (the rush hours will be from 7:30 to 9:30 and from 13:30 to 15:30). The ticket's price will be exactly the same as in the current urban tube and will be integrated in the charging system of the Consortium of Transports of Seville. The quays will have an useful surface of the main float of 25 x 6 square meters, a docking canal of 8,30 meters and a float of 25 x 2 square meters for the automatic docking system. The quay will operate with until 4 meters differences in the water level. It is planned the construction of a separated canal of 3 kms. at the inner basin to allow the private use of the river and not to interfere in the rowing centre of high performance. This canal will be built between the Alamillo bridge and the walkway of La Barqueta. It will be built like a concrete wall of 3 meters depth on piles, with two meters under water and one meter above the surface in its middle level. There are planned two modal transport exchangers at each end of the inner basin (south lock, north buffer of Alamillo). There will be 12 stops in the centre of Seville and another 10 stops in the towns at the river. All exterior stops and the two exchangers will have extensive dissuasive parking to attract the users of the towns not near to the river and so avoid the pressure in the interior of the capital. The boats will not have to cross the lock (this will represent an unacceptable delay), not either the north buffer, simply the users will have to change the line, changing boats. These lines will be in a distance of only some meters. The change will take place under cover, inside the two exchangers in less than one minute. The system VTS, AIS, and the communications TETRA have been designed to be shared with the commercial harbor of Seville with the aim of facilitating and coordinating the operations of both entities.

Claims

1. Urban and interurban regular transport system for passengers using fluvial and maritime lanes or RiverTube. The system is completely described in the initial description of this document. It represents a

novel, completely defined and repeatable system in the majority of the world's cities. The novel system consists in unifying a set of innovations to get the same effectiveness as a subterranean tube, but with 90% less of necessary investment: a) Use the existent communication lanes (rivers and seas), b) Include an automatic docking system to allow the exchange of passengers at the stops similar to the subterranean tube in times and number of users and with only one worker per boat, c) Use stops as closed buildings and large quays as docks instead of docks at open air, d) Use the most sophisticated control systems to guarantee the security and the traffic control: Navigation Simulators for the training of the pilots, VTS, AIS, TETRA, SCADA.

2. RiverTube system, according to claim 1, **characterized in** having an automatic docking system for the boats. It consists in the unit of the Quay-Boat, which guarantees the docking, exchange of passengers and departure of the boat in seconds, with total security and efficacy. The quay (described in the claim 4) operates together with the hydraulic platforms (described in claim 3) foldable (Fig. 3 unfolded and Fig. 4 folded), each one at each side of the boat, which will be unfolded over the quay in the docking moment and engages the boat to the quay (Fig. 6 y Fig. 7). The system will be operated exclusively by the docking pilot. The hydraulic foldable platforms are steel plates and have as a function to anchor the boat to the quay, level the height of the quay and of the boat to allow the access to the users without barriers. There are irrelevant for the definition of the invention, the thickness and the composition of the material of the platform, which will be of enough resistance to support the boat anchored to the quay and will vary with the specification of the boat. The system disposes of a closed television circuit and the necessary illumination system for the sake that the pilot has the absolute security that the quay is clear when he is going to lower the platforms. The pilot has a lever which will allow him to unfold until 100° with respect to the vertical each platform simultaneously. This will allow correcting the height's differences of boat and quay according to the different load of both of them. Besides, he will have a control device to open and close the automatic doors of the boat and of the quay. The boat will be provided with two lateral propellers in the front part to steer easily the movement of the docking.

3. RiverTube System, according to claim 1, **characterized in that** it is provided with hydraulic platforms of the boat, consisting in: a) Two platforms of 1 meter height and with the same length than the access doors to the boat, one on the port side and the other one at starboard. These platforms are anchored to the boat in its inferior part to a rotation axe, which

allows it to rotate according to Fig. 3 and Fig. 4. They are managed through a system of three or more hydraulic arms that allow them to rotate until 100° (Fig. 3) of the vertical or the state of rest (Fig. 4). b) A structural reinforcement as base platform of the boat, over which the floats will be placed from below and the whole structure from the top. This platform or reinforcement guarantees that the boat is capable to go up to the quay when the hydraulic ramps go down. The weight of the boat and of the quay summed up will achieve a balance position with the level of the water. The unfolded platforms will do as access ramps to the boat without any remarkable unevenness. The joints will be protected with rubber bands that avoid accidents. Depending on the type, size and weight of the boat and the maximum number of persons that the quay and the boat support, there will be necessary to make a design to guarantee the operability of the system by differences of level of the quay and the boat. In general, the system will operate with a maximum angle of 100° of the vertical for the platforms, what limits the difference in height between the quay and the access level to the boat. This study is not important in the definition of the invention, for it will have to be carried out for each implementation of the system.

4. RiverTube System according to claim 1, **characterized in** having a quay for the automatic docking (or dock or pier). The quay is represented with its separated parts in Fig. 5. The design of the quay is a very important invention in the system, for it is fundamental part of the automatic docking system (claim 2). Its design allows handling it as one unit (Fig. 5). It is inserted in the station's building, with a system of rails that only lets it go down or up with the level of the water. It has a system of mobile access ramps (Fig. 5-2) that allow the access from the level of the building station to the level of the quay. These ramps will be fixed at the superior part to the building and at the inferior part to the quay. The quay can be detached from the building and be moved floating on the water to another place or repair or maintenance station. Besides, a temporal stop can be set up in any place setting four piles in the water and container-station and unify them by a ramp. The container-station has a system of lathes for the access control to create a temporal stop at any point in the fluvial lane. The quay has available a float (Fig. 5-4) separated from the main unit (Fig. 5-1) by underwater arms (Fig. 5-5) that allow the access of the boat between the float and the main unit and unifies them jointly. The boat will unfold its hydraulic ramps to anchor at the quay, fixing to the float from one side and to the main unit from the other side. This double fixation will provide the necessary stability to allow the exchange of passengers with total security and agility. The quay is built with tight cubes that multiply

the security against sinking in case of an accident, for it has to support the weight of, at least, the persons that fit in the boat. The inferior part of the quay is set up by a series of floats with the form of a truncated inverted pyramid (Fig. 5-6) that guarantees a minimal vertical displacement with the weight difference when the users' number change at the surface. This design has to be calculated for each implementation of the system, but the invention proposes the most adequate form. All the elements of Fig. 5 will be unified forming an indivisible unit. Only the mobile ramps (Fig. 5-2) can produce a scissor's movement according to the variation of the water's level. Thank to the rail guides (Fig. 5-2), the ramps will move automatically according to the water's level, keeping the same angle: the curved angles (Fig. 5-3), calculated like an arch with the centre in the origin of the inferior ramp in the main unit, force the intermediate landing, union of both ramps, to keep at the middle of the course without the necessity of help or external control. The four rails (Fig. 5-3) are fixed to the basement of the quay. Each implementation of the quay should fix its security level respecting to the maximal authorized weight and the level of maximal waves permitted for the operation. The maximal weigh is determined by the floatability capacity of the quay and by the maximal height's difference of the boat/quay permitted by the automatic docking system. The quay, even if it is fixed to the station over four vertical rails, should be also anchored to the bottom and fixed to the bank by two cables that operate in opposed directions. Besides, it should be provided with the security and operational protocols required to fix and secure them in case of exceptional situations (floods, rises, etc.) These situations will depend on each particular implementation of the model. The fixation to the station should be designed to stand these eventualities. The quays have available meteorological sensors to know the conditions of the stream's speed and the wave's intensity to inform automatically of the operation's conditions at each stop. The pilots will possess all information at real time to carry out the operation of docking with total security. The boats and the stations will transmit these data through the communication's system TETRA. The quay and each boat will have a sensor to measure the sinking level of the boat, through which it will be possible to calculate the weight that is supporting and limit the access of the users to the quay. In each moment we will know the operation that the pilot has to manage and the level of separation of the height between each quay and each boat. These control systems represent an innovation and guarantee the agility and the security of the operations. The stations will have a public address system managed by the control and cameras centre of the closed circuit of television. They can operate without personnel, but in congestion periods, the

presence of workers and security personnel will be required.

Amended claims under Art. 19.1 PCT

1. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, in which participate existent communication lanes such as rivers and seas, in which docking points or exchange stations will be established for the exchange of passengers, materialized in closed buildings provided with quays with docks, **characterized in that** for each station there will be defined a fixed part, or area for the access and cancellation of the tickets through the corresponding lathes, and at least one floating quay, to which it will be accessed from a series of articulated ramps, so that said quay will adapt to the existent water's level, while the transport vehicles are materialized in boats, with the particularity that each quay is closed through a plurality of automatic doors coinciding in position with the ones defined in the boat, with large capacity, being foreseen that between the quay and the boat there will be established a system of automatic docking materialized in an hydraulic ramp, that when inoperative remains vertical and when in docking disposition folds horizontally, covering the required foreseen distance between the quay and the boat.
2. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** the automatic docking system for the boats in form of an hydraulic ramp (9) integrates in the lateral of the boat.
3. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** the hydraulic platforms are one meter high and of the same length as the access doors to the boat, one on the port side and the other one at starboard, anchored to the boat at its inferior part, assisted by several hydraulic arms, having a structural reinforcement as base platform of the boat, over which floats are placed inferiorly.
4. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** the seals of the platforms are protected with rubber bands.
5. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** the quay includes a rail system, through which it is movable vertically in respect to the station and avoids any different oscillation of the same.

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6. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** the quay is built with tight cubes, while its inferior part is built by a series of floats with the form of an inverted truncated pyramid forming an indivisible unit. This geometric guarantees a minimal height's change of the quay by the change of weight caused by the rise or descent of the passengers.

7. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** the quays include meteorological sensors (for temperature, water streams, waves,...) and transmission's means of said data to the pilots of the boats, including similarly public address systems to guarantee the security of the exchange operation by situations of flood or high waves.

8. Urban and interurban regular transport system for passengers using fluvial and maritime lanes, according to claim 1, **characterized in that** it includes maritime traffic control systems (VTS: Vessel Traffic System) with control per radar, AIS sensors; radio communications in standard maritime frequency and digital communications TETRA to communicate the parameters of the boat to the control centre; systems of television closed circuit; public address system; access control systems and navigation simulators to guarantee the effectiveness, punctuality and security of the transport system.

Statement under Art. 19.1 PCT

With the present writing, it will be answered the written opinion, in charge of the international search in the file of reference.

This part coincides with the examiner's opinion in that part of the characteristics presented in the claim's content are anticipated in the document D1.

Nevertheless, the mentioned document D1 differs substantially from the system foreseen in the present invention, so that said document targets in the definition of a quay that guarantees the security of the passengers' transit between land and water, defining a complex system of passenger's exchange and a quay that regulates mechanically and electronically its stability. The system transports actively the passengers in a gondola from land to the quay, where the boat is anchored with an anchoring system that guarantees the security of the exchange. The system needs that all passengers are simultaneously at land to be transported all together with security to the quay. This system penalizes the speed for the security, forcing the passengers to carry out an extra exchange between the bus and the gondola and later, between the gondola and the quay.

On the contrary, in the epigraph's patent presents an automatic docking system that guarantees, not only the security of the exchange, but also the agility of itself.

The question is to achieve an urban transport system that is fast and sure, using fluvial and maritime lanes, and in which participates a novel unit boat-quay that guarantees this agility. 5

The essential difference of both innovations is that in document D1 it will be defined a complex system to guarantee the security of the passengers, leaving the same the docking of the boats, this means, assuring its anchoring, while in the system of the present invention it will be designed a system that speeds the docking and undocking of the boat to allow using the boats exactly the same as a tube, with the same transfer speeds and number of seats. 10 15

So, it is dealt with two completely different systems with different purposes.

In any case, it will be proposed a new set of claims in which there will be defined clearly a pre-characterizing part, which does not pretend exclusivity rights, and a characterizing part, in which only the novel characteristics of the invention are included. 20

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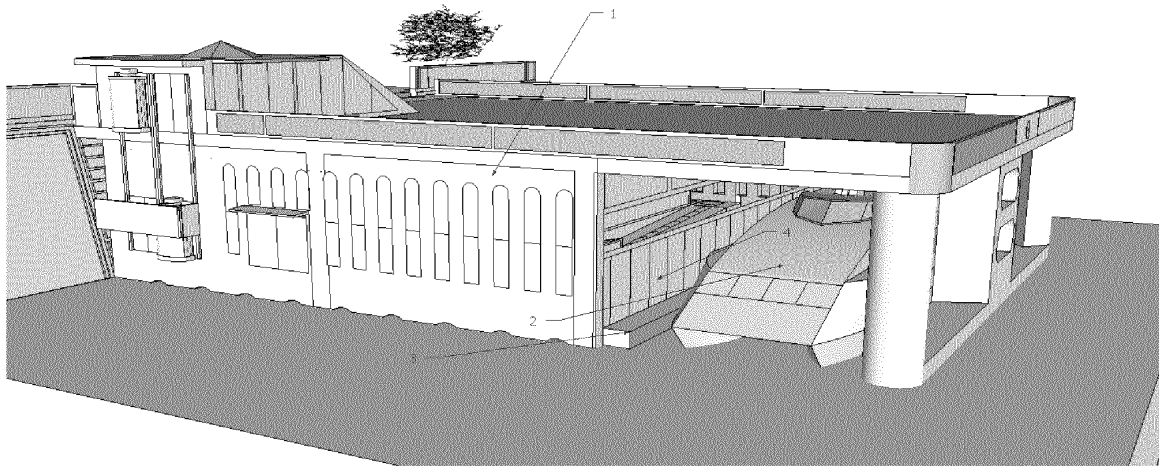


Fig.1

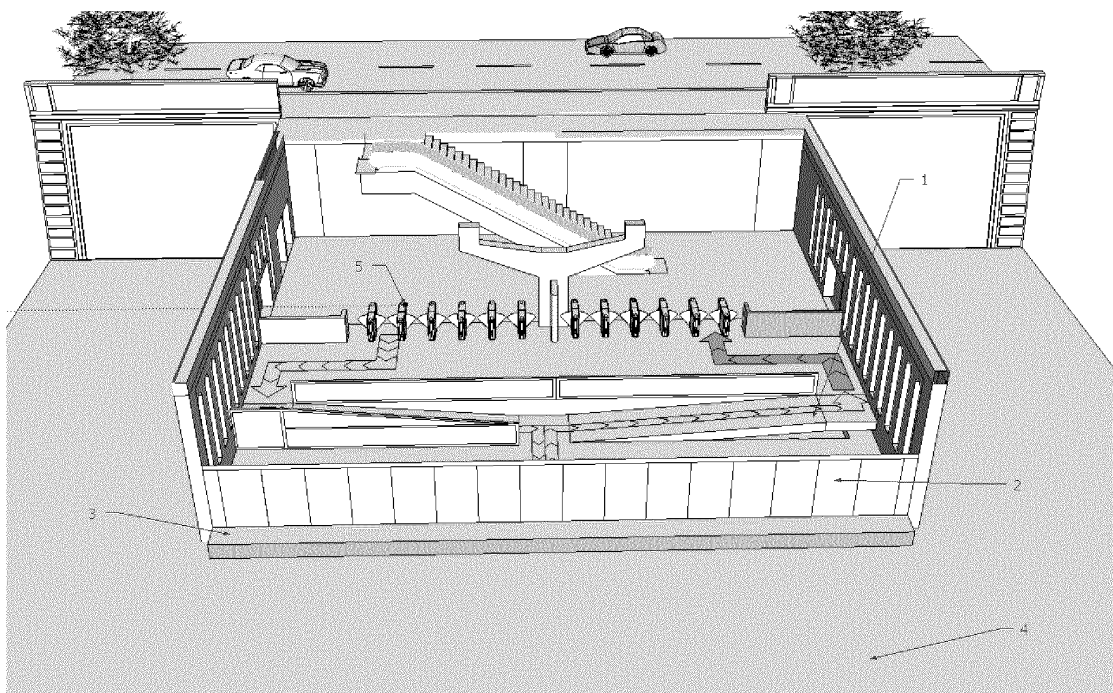


Fig.2

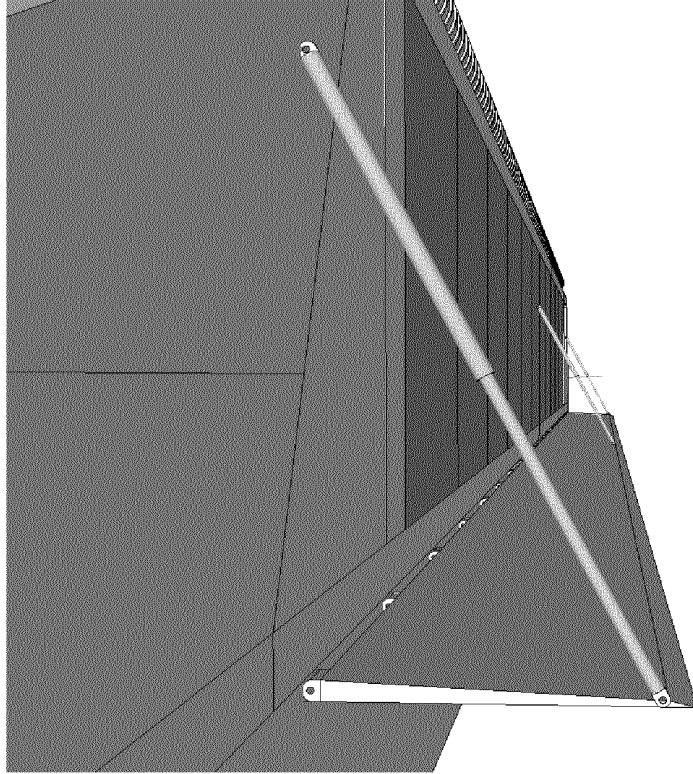


Fig. 3

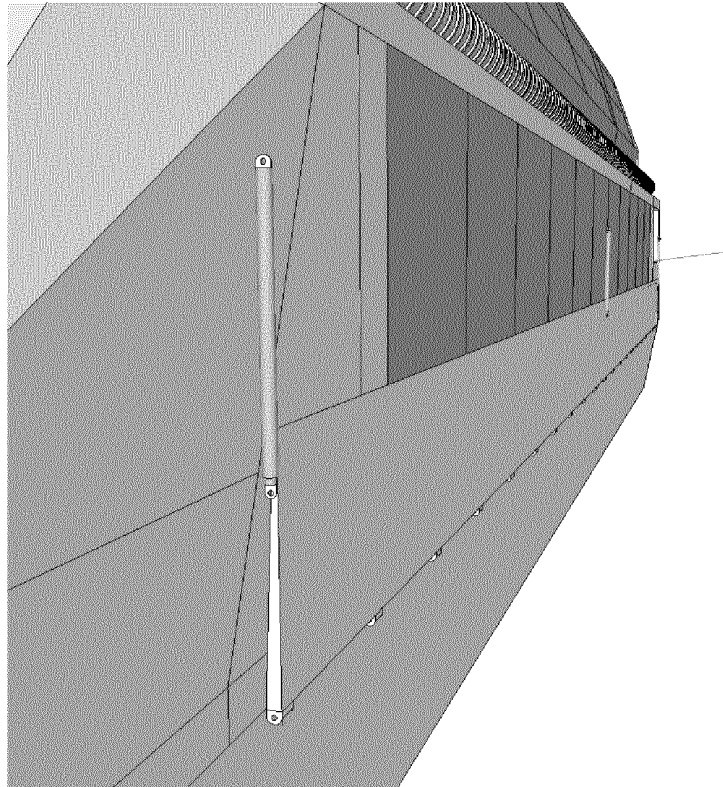


Fig. 4

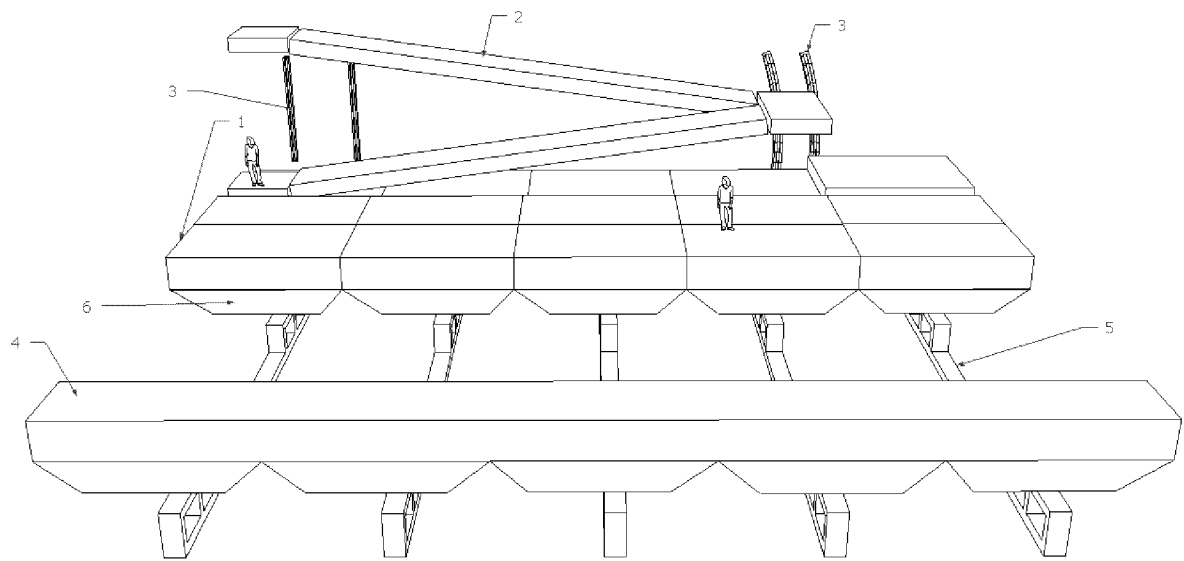


Fig.5

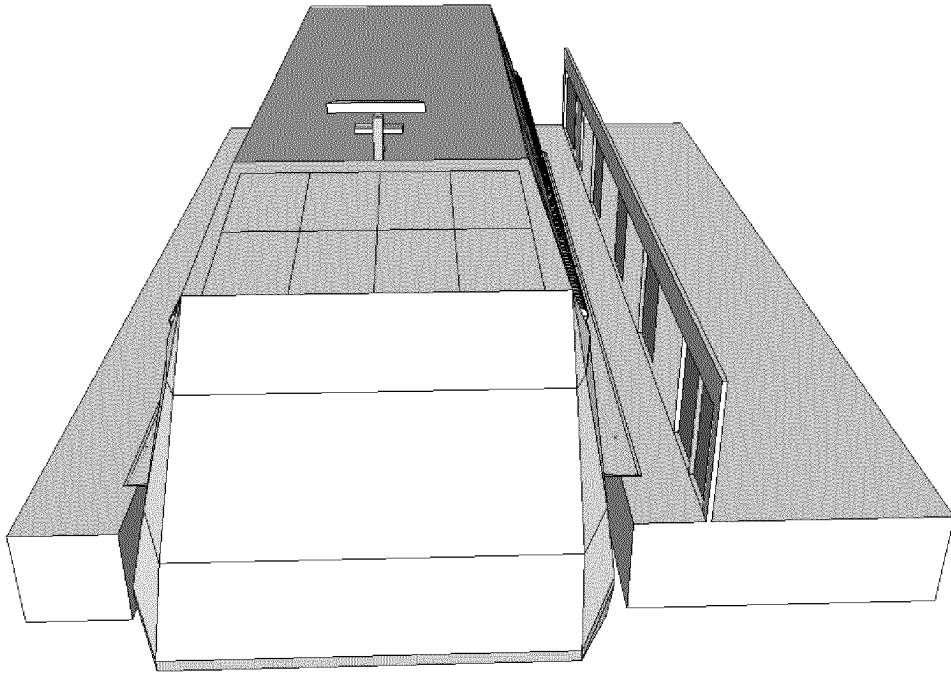


Fig.6

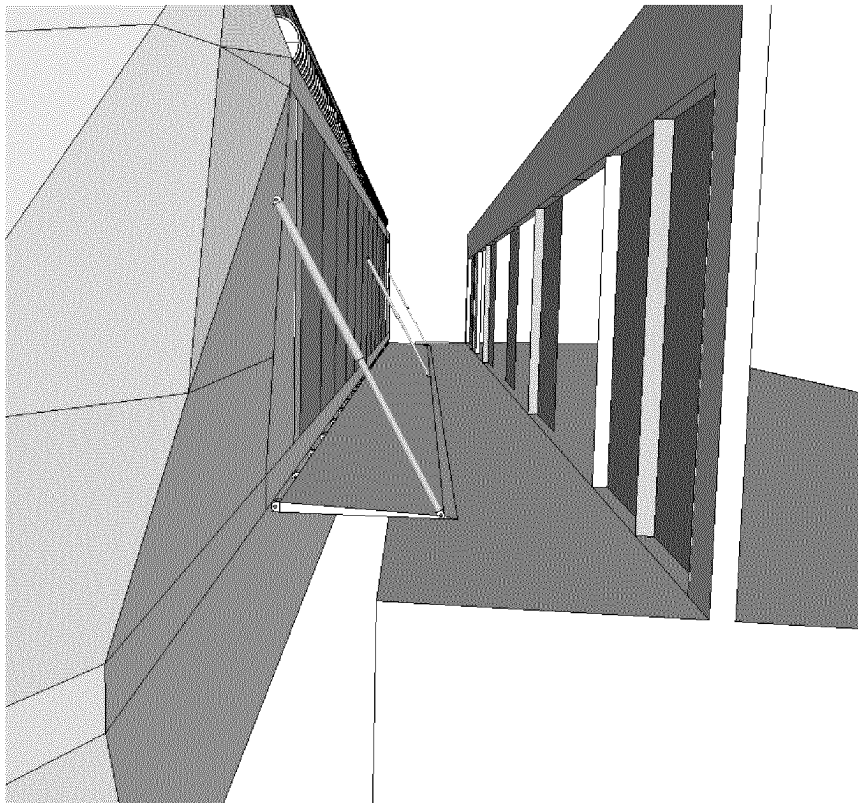


Fig.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2012/000302

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E02B, E01D, B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, INVENES, Internet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003056708 A1 (VOLLMERHAUSEN ROBERT H) 27/03/2003, description; figure 2, 7b.	1
A	DE 19616864 A1 (STEINEBACH GUENTER ET AL.) 20/11/1997, abstract; figure.	1
A	US 2007044702 A1 (WALDOCK WILLIAM L) 01/03/2007, figures.	2,3
A	WO 0168442 A1 (HAMWORTHY KSE AB ET AL.) 20/09/2001, figures.	2,3
A	WO 2007093775 A2 (XCROSSWATER LTD ET AL.) 23/08/2007, figures.	4
A	US 2879735 A (WILLIAM POINTER ROBERT) 31/03/1959, figures.	4

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance.

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure use, exhibition, or other means.

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search
04/04/2013

Date of mailing of the international search report
(09/04/2013)

Name and mailing address of the ISA/

OFICINA ESPAÑOLA DE PATENTES Y MARCAS
Paseo de la Castellana, 75 - 28071 Madrid (España)
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Authorized officer
D. Herrera Alados

Telephone No. 91 3493412

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2012/000302

C (continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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CLASSIFICATION OF SUBJECT MATTER

E02B3/20 (2006.01)

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B63B21/50 (2006.01)

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